Proposed Test Protocol for Calculating the Energy Efficiency of Internal AC-DC Server Power Supplies

EPRI PEAC Corporation

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1. Scope

This document specifies a test protocol for calculating the energy efficiency of internal ac-to-dc power supplies typically used in computer servers. Internal power supplies are located in the same housing as the product that they power. An example of this type of power supply is a 1U rack server power supply, which has multiple output voltages: +12 V, +5 V, +3.3 V, 5VSB, and -12 V (see Appendix A). External power supplies, often referred to as ac adapters, are contained in a housing separate from the devices they power. This type of power supply is not included in the scope of this document. In addition, ac-to-ac voltage conversion equipment, such as ac transformers, and dc-to-dc voltage conversion equipment are not included in the scope of this document. The test protocol in this document applies specifically to single-phase power supplies with ac input and a single or multiple dc outputs.

Building upon the efficiency test protocol outlined in Section 4.3 of IEEE Std. 1515-2000, *IEEE Recommended Practice for Electronic Power Subsystems: Parameter Definitions, Test Conditions, and Test Methods*, the test protocol specified here establishes a consistent loading guideline for ac-to-dc internal server power supplies that often have multiple output voltages.

1.1 Intent

The intent of this document is to use existing industry standards that have been created for electronic test and measurement to develop a consistent and repeatable method for measuring the energy efficiency of ac-to-dc internal server power supplies. Existing standards occasionally give conflicting approaches and requirements for efficiency testing that this test protocol seeks to clarify. In addition, other documents give multiple protocols, whereas this document focuses solely on the efficiency of the server power supplies only.

2. References

The following list includes documents used in the development of this proposed test protocol; if the following publications are superseded by an approved revision, the revision shall apply:

1. IEEE Std 1515-2000, *IEEE Recommended Practice for Electronic Power Subsystems: Parameter Definitions, Test Conditions, and Test Methods*.
2. IEEE Std 519-1992, *IEEE Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems*.
3. IEC 62301 Ed 1.0, *Measurement of Standby Power* (Committee Draft).
4. Draft IEC 62018 Ed. 1, *Energy Management Requirements*.
5. UL 60950, 3rd Edition, *Information Technology Equipment – Safety – Part 1: General Requirements*, April 1, 2003.
6. IEC 61000-4-7 Ed.2, *Electromagnetic Compatibility (EMC) - Part 4-7: Testing and Measurement Techniques - General Guide on Harmonics and Interharmonics. Measurements and Instrumentation, for Power Supply Systems and Equipment Connected Thereto*.
7. IEC 61000-3-2, *Electromagnetic Compatibility (EMC) – Part 3-2: Limits – Limits for Harmonic Current Emissions (Equipment Input Current ≤16 A per Phase)*.
8. IEC 60050, *International Electrotechnical Vocabulary – Electrical and Electronic Measurements and Measuring Instruments*.
9. IEEE 100, *The Authoritative Dictionary of IEEE Standards Terms*.
10. *Power Supply Design Guidelines* (*website: www.formfactors.org*), Intel Corporation.
11. *Energy Star Guidel*ines (website: www.energystar.gov), United States Environmental Protection Agency.

3. Definitions

For the purpose of this document, the following definitions apply. If terms are not defined here, then IEC 60050, IEC 62301, and IEEE 100 are recommended.

3.1 AC-DC Power Supply

This term refers to devices designed to convert ac voltage to dc voltage for the purpose of powering electronic equipment.

3.2 AC Signal

A time-varying signal whose polarity varies with a period of time *T* and whose average value is zero (ref. IEEE Std 1515-2000).

3.3 Ambient Temperature

Temperature of the ambient air immediately surrounding the unit under test (UUT) (ref. IEEE Std 1515-2000).

3.4 Apparent Power (S)

The total or apparent power (S) is the product of rms voltage and current (VA).

3.5 Dc Signal

A signal whose polarity and amplitude do not vary with time (ref. IEEE Std 1515-2000).

3.6 Efficiency

Efficiency is the ratio, expressed as a percentage, of the total real output power (produced by a conversion process) to the real power input required to produce it, using the following equation:

$$\eta = \frac{\sum_i P_{o,i}}{P_{in}} \times 100 \qquad \textbf{\textit{Eq. 3-1}}$$

where $P_{o,\,i}$ is the output power of the i^{th} output. The input power (P_{in}), unless otherwise specified, includes all housekeeping and auxiliary circuits required for the converter to operate.

3.7 Enclosed-Frame Modular Internal Server Power Supply

Power supplies encased in a modular enclosure, as shown in Figure B-1. These enclosures are installed inside the appliance, and their inputs and outputs are easily accessible

3.8 Multiple-Output Power Supply

Power supplies designed to provide more than one dc voltage level, including those with two, three, four, or more voltage levels (or bus).

3.9 Output Voltage Bus

This refers to any of the dc outputs of the power supply, to which loads can be connected and current and power supplied. These buses may be different voltage levels depending on the design of power supply and the product being powered.

3.10 Rated AC Input Voltage

The supply voltage declared by the manufacturer in the specification of the power supply. For a single-phase power supply, this refers to line-to-neutral voltage, and for a three-phase power supply, this refers to the line-to-line voltage.

3.11 Rated AC Input Voltage Range

The supply voltage range (minimum/maximum) as declared by the manufacturer in the specification of the power supply.

3.12 Rated DC Output Current

The dc output current for each output dc bus of the power supply as declared by the manufacturer in the specification of the power supply. In the case of a discrepancy, the nameplate value will take precedence.

3.13 Rated DC Output Current Range

The dc output current range (minimum/maximum) for each output voltage bus of the power supply as declared by the manufacturer in the specification of the power supply.

3.14 Rated DC Output Power

The maximum available output power as declared by the manufacturer either within a datasheet or on the nameplate label. It is typically less than the sum total of individual bus power.

3.15 Rated DC Output Voltage

The dc output voltage for each output voltage bus of the power supply as declared by the manufacturer in the specification of the power supply.

3.16 Rated Input Frequency

The supply ac input frequency of the power supply as declared by the manufacturer in the specification of the power supply.

3.17 Rated Input Frequency Range

The supply ac input frequency range (minimum/maximum) of the power supply as declared by the manufacturer in the specification of the power supply.

3.18 Rated Input Current

The input current of the power supply as declared by the manufacturer in the specification of the power supply.

3.19 Rated Input Current Range

The input current range (minimum/maximum) for a power supply as declared by the manufacturer in the specification of the power supply.

3.20 RMS (Root Mean Square)

The square root of the average of the square of the value of the function taken throughout the period. For instance, the rms voltage value for a sine wave may be computed as:

$$V_{RMS} = \sqrt{\frac{1}{T}\int_0^T v^2(t)dt}$$

where:

T is the period of the waveform,

$V(t)$ is the instantaneous voltage at time t, and

V_{RMS} is the rms voltage value (ref. IEEE Std 1515-2000).

3.21 Single-Output Power Supply

Power supplies designed to provide one dc voltage level on one output voltage bus.

3.22 Steady State

The operating condition of a system wherein the observed variable has reached an equilibrium condition in response to an input or other stimulus in accordance with the definition of the system transfer function. In the case of a power supply, this may involve the system output being at some constant voltage or current value (ref. IEEE Std 1515-2000).

3.23 Test Voltage Source

The test voltage source refers to the device supplying power (voltage and current) to the unit under test (UUT).

3.24 Total Harmonic Distortion (THD)

The ratio, expressed as a percent, of the rms value of an ac signal after the fundamental component is removed to the rms value of the fundamental. For example, THD of current can be defined as:

$$THD_I = \frac{\sqrt{I_2^2 + I_3^2 + I_4^2 + I_5^2 + ...I_n{}^2}}{I_1} \qquad \textbf{Eq. 3-3}$$

where I_n = rms value of nth harmonic of the current signal.

3.25 UUT

The abbreviation for unit under test (ref. IEEE Std 1515-2000).

3.26 Voltage Unbalance

Voltage unbalance is the maximum difference between rms phase-to-neutral or phase-to-phase voltage amplitudes at the UUT input terminals. For example, for a wye-connected, three-phase system:

$$V_{UNB} = \left(\max\left[V_{AN}, V_{BN}, V_{CN}\right] - \min\left[V_{AN}, V_{BN}, V_{CN}\right]\right) \quad \textbf{\textit{Eq. 3-4}}$$

where

V_{AN}, V_{BN}, V_{CN} are the phase voltage magnitudes and

V_{UNB} is the maximum phase voltage unbalance.

Percent voltage unbalance is calculated by multiplying the maximum voltage unbalance by 100 and dividing the result by the average of the three phase voltages:

$$V_{UNB\%} = \frac{V_{UNB}}{\left(\frac{V_{AN} + V_{BN} + V_{CN}}{3}\right)} \times 100 \quad \textbf{\textit{Eq. 3-5}}$$

(ref. IEEE Std 1515-2000)

4. Standard Conditions for Efficiency Testing

4.1 General Provision

Input voltage, frequency, and output bus loading are among the variables that can impact the efficiency of an ac-to-dc power supply. Sections 4.2 and 4.3 below recommend a minimum set of requirements in order to control these variables while measuring internal power supply efficiency. Beyond these minimum conditions, the manufacturer and user of the power supply may determine additional requirements, such as harmonic distortion or unbalance specification as need be.

4.2 Input Voltage and Frequency

The recommended input voltage and frequency is 115 VAC +/- 1% and 60 Hz +/- 1%[1].

4.3 Power Supply Loading

The efficiency of the power supply shall be measured at 20%, 50%, and 100% of rated current[2]. In addition to these three load conditions, other loading conditions may be identified that are relevant to the manufacturer and user of the power supply. Procedures for loading power supplies are described in detail in Section 6.1.1 below[3].

Testing at a load condition below 25% load condition should be guided by IEC 60180 Ed 1.0, *Measurement of Standby Power*, which establishes the measurement methods for low-power-mode operation of an appliance.

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[1] The input voltage used should be clearly noted on the test report.

[2] The loading points of 20%, 50%, and 100% were chosen to maintain consistency with the loading guidelines for personal computers. Reference: http://www.formfactors.org, ATX12V Power Supply Design Guide v2.0, page 18.

[3] Loading guidelines are needed to ensure consistency when measuring the efficiency of server power supplies with multiple outputs. Guidelines currently do not exist, but may be added in the future. Reference: http://www.ssiforum.org/html/adoptedspecs.asp, for a specification that defines a non-redundant power supply that supports an entry-level server.

5. Instrumentation and Equipment

5.1 General Provisions

These procedures are meant to ensure the accurate and consistent measurement of power supplies across testing laboratories. Please refer to Annex B of IEEE 1515-2000, *IEEE Recommended Practice for Electronic Power Subsystems: Parameter Definitions, Test Conditions, and Test Methods*, for guidelines for general test practices, and to Annex D of IEC 62301, Ed. 1.0, *Measurement of Standby Power*, for a discussion on evaluating measurement uncertainty.

5.2 Test Voltage Source

Regardless of the ac source type, the THD of the supply voltage when supplying the UUT in the specified mode shall not exceed 2%, up to and including the 13th harmonic (as specified in IEC 62301). The peak value of the test voltage shall be within 1.34 and 1.49 times its rms value (as specified in IEC 62301).

5.3 Test DC Loads

Active dc loads such as electronic loads or passive dc loads such as rheostats used for efficiency testing of the ac-to-dc power supply shall be able to maintain the required current loading set point for each output voltage within an accuracy of ±0.5%.

5.4 Measurement Points

Measurements should be made as close as possible to both the ac input and dc outputs of the power supply with the intention of minimizing error due to voltage drop. Kelvin-type connections are preferred.

5.5 DC Connector

Server power supplies often use edge-type connectors of various design. Part numbers for the mating connector can be found within the adopted specification page of http://www.ssiforum.org. However, the listed mating connector is often difficult to procure in small quantities. In this case, a generic connector can be substituted and modified to fit.

5.6 Measurement Instrumentation Accuracy

Power measurements shall be made with a suitably calibrated voltmeter and ammeter or power analyzer. As is specified in IEC 62301, measurements of active power of 0.5 W or greater shall be made with an uncertainty of ≤2%. Measurements of active power of less than 0.5 W shall be made with an uncertainty of ≤0.01 W. The power measurement instrument shall have a resolution of 0.01W or better for active power. Measurements of voltage and current shall be made with an uncertainty of ≤2%.

5.7 Test Room

The following are recommendations for the test room environment, based on IEC 62301, Ed. 1.0, *Measurement of Standby Power:*

- The tests shall be carried out in a room in which the air speed close to the UUT is ≤0.5 m/s.
- The ambient temperature shall be maintained at 23°C (+/- 2°C) throughout the test.

5.8 Warm-Up Time

Internal temperature of the components in a power supply could impact the efficiency of the unit. As a general recommendation before testing, each UUT should be loaded up to the test load for a period of at least five minutes or, preferably, for a period sufficient that the total input power reading over two consecutive five-minute intervals does not change more than 5%. Refer to IEC-62301 Ed 1.0, *Measurement of Standby Power*.

6. Loading Criteria for Efficiency Testing

6.1 General Provisions

Loading criteria for ac-to-dc power supplies shall be based on rated dc output current and not on rated dc output power. For example, consider the 50% loading condition for a 50 W, +5 V single-output power supply with a rated dc output current of 10 A. The load condition is achieved by adjusting the dc load (using a rheostat or electronic load bank) connected to the 5 V bus output so that 5 A of current is flowing on the bus. This is not equivalent to adjusting the load bank until the load on that bus dissipates 25 W of output power. For power supplies with multiple outputs, defining a loading standard is complex because the sum of individual rated currents may exceed the rated dc output current of the power supply. The recommended approach for ensuring consistent loading criteria for multiple-output internal server power supplies is the proportional allocation of loading for each individual dc output voltage bus. This approach is defined below.

6.1.1 Loading Guidelines for Multiple-Output Power Supplies Without Manufacturer Loading Specifications

The following sections provide procedures for loading multiple-output power supplies by using a calculated derating factor (*D*).

6.1.1.1 Method of Proportional Allocation Based on Rated DC Output Current

In this case, the manufacturer has provided rated dc output current limits for each bus and a rated dc output power for the power supply. The approach for loading criteria is as follows:

Assume a power supply with four output voltage buses. A sample output specification of this power supply is shown in Table 6-1.

Table 6-1: Labels for Output Variables

<table>
<tr><th>Rated DC Output Voltage of Each Bus</th><th>Rated DC Output Current of Each Bus</th><th>Rated DC Output Power</th></tr>
<tr><td>V_1</td><td>I_1</td><td rowspan="4">P</td></tr>
<tr><td>V_2</td><td>I_2</td></tr>
<tr><td>V_3</td><td>I_3</td></tr>
<tr><td>V_4</td><td>I_4</td></tr>
</table>

Step 1: Calculate the derating factor *D* using the procedure outlined in Equation 6-1.

$$D = \frac{P}{(V_1 * I_1) + (V_2 * I_2) + (V_3 * I_3) + (V_4 * I_4)} \qquad \textit{Eq. 6-1}$$

Step 2: If $D \geq 1$, then it is clear that loading the power supply to the rated dc output current for every bus does not exceed the overall rated dc output power for the power supply. For this case, the required output dc current on each bus for *X%* loading can be determined by:

$$I_{bus} = X * I_n \qquad \textit{Eq. 6-2}$$

where I_{bus} is the required output dc current for that bus at that percent load and I_n is the rated dc output current for that bus. For example, Table 6-5 shows the guideline for 50% loading of the power supply based on $D \geq 1$.

Table 6-2: Loading Guideline for* D≥1 *with X=50%

Output Voltage of Each Bus	50% Loading Guideline
V_1	$0.50*I_1$
V_2	$0.50*I_2$
V_3	$0.50*I_3$
V_4	$0.50*I_4$

Step 3: If, however, $D<1$, it is an indication that loading each bus to its rated dc output current will exceed the overall rated dc output power for the power supply. In this case, use the following loading criteria using the derating factor:

$$I_{bus} = D * X * I_n \qquad \textit{Eq. 6-3}$$

This effectively derates the output dc current of each output voltage bus such that at 100% load, the overall load will equal the rated dc output power of the power supply. It also derates other load levels. For example, Table 6-6 shows the guideline for 50% loading of the power supply based on $D<1$.

Table 6-3: Loading Guideline for* D<1*, with X=50%

Output Voltage of Each Bus (V)	Output Current of Each Bus (A)
V_1	$D * 0.50 * I_1$
V_2	$D * 0.50 * I_2$
V_3	$D * 0.50 * I_3$
V_4	$D * 0.50 * I_4$

6.1.1.2 Method of Proportional Allocation Based on Overall Power Supply Rated DC Output Power and a Subgroup Output Voltage Bus Rated DC Output Power

In some cases, the power supply manufacturer specifies the rated dc output power for a subgroup of buses in addition to the overall rated dc output power of the power supply. An example of this type of power supply is a server power supply with an overall rated dc output power of 400 W (refer to Table 6-4) and a rated dc output power of 90 W for the +5 V and +3.3 V buses combined. Loading each bus to its individual rated dc output current may now exceed both the overall power supply's rated dc output power (536.8 W in this case) and the subgroup's rated dc output power (112.8 W for the 5V and 3.3V buses in this case). This section outlines a procedure for ensuring that both maximum limits are met.

Table 6-4 Loading Specifications for a 400 W 1U Rack Server with EPS1U Formfactor

Voltage (V)	Minimum Continuous (A)	Maximum Continuous (A)	Maximum Continuous Watt (W)
+3.3 V	0.5	16	52.8
+5 V	0.5	12	60
12 V1	0.2	18	216
12 V2	0.5	16	192
12V3	0	0	0
-12 V	0	0.5	6
+5 VSB	0.1	2	10
Total Maximum Power Output (W)			**536.8**
Rated Power Output (W)			**400**
Combined Max. Continuous Output Power (W) on 5V and 3.3V Shall Not Exceed			**90**

Assume a power supply with four output voltage buses with an overall rated dc output power and a rated dc output power for two of the output voltage buses. A sample output specification of this power supply is shown in Table 6-5.

Table 6-5:Output Variables Labels for Maximum Rating of Subgroup Output Voltage Bus

<table>
<tr><th>Output Voltage of Each Output Bus</th><th>Maximum Rated Output Current of Each Bus</th><th>Maximum Rated Output Power</th><th>Maximum Rated Output Wattage for Buses V_2 and V_3</th></tr>
<tr><td>V_1</td><td>I_1</td><td rowspan="4">P</td><td rowspan="4">Q, where $Q < P$</td></tr>
<tr><td>V_2</td><td>I_2</td></tr>
<tr><td>V_3</td><td>I_3</td></tr>
<tr><td>V_4</td><td>I_4</td></tr>
</table>

Step 1: Calculate a new derating factor D_:

$$D' = \frac{Q}{(V_2 * I_2) + (V_3 * I_3)} \qquad \textbf{\textit{Eq. 6-4}}$$

Step 2: If *D_* ≥1, then it is clear that the subgroup rated dc output currents will not be exceeded when individual buses are loaded to their maximum limits. If this is the case, one can proceed as above with the evaluation and use the original derating factor D , *D_* will not need to factor into the loading criteria.

Step 3: If, however, *D_* <1, then the subgroup limit will be exceeded when the two buses in the subgroup are loaded to their individual maximums. In this case, the subgroup bus load currents must be derated as follows:

$$I_{subgroupbus} = D' * X * I_n \qquad \textbf{\textit{Eq. 6-5}}$$

For example, Table 6-6 shows the guideline for 50% loading of the power supply subgroup buses based on *D_* <1.

Table 6-6: Loading Guideline for* D_*<1 with X=50%

Output Voltage of Each Bus	Output Current of Each Bus (A)
V_2	*D_* * 0.50 * I_2

V_3	$D\_ * 0.50 * I_3$

Step 4: Now a last derating factor *D_* must be determined to ensure that the remaining bus loads do not exceed the overall power supply rated dc output power as follows:

$$D'' = \frac{P - Q}{(V_1 * I_1) + (V_4 * I_4)} \qquad \textbf{\textit{Eq. 6-6}}$$

Step 5: If *D_* ≥1, then loading the remaining buses to their individual maximum current limits will not cause the overall power supply rated DC output power to be exceeded. In this case, the subgroup bus should be loaded as in Table 6-6, and the remaining buses loaded to their individual limits.

Step 6: If, however, *D_* < 1, then loading the remaining buses to their individual maximum current limits will cause the overall power supply rated dc output power to be exceeded. In this case, the subgroup buses should be loaded as in Table 6-7, and the remaining buses derated as below:

$$I_{remaining} = D'' * X * I_n \qquad \textbf{\textit{Eq. 6-7}}$$

For example, Table 6-9 shows the guideline for 50% loading of the remaining buses based on *D_* <1.

Table 6-7: Loading Guideline for* D_*<1 with X=50%

Output Voltage of Each Bus (V)	Output Current of Each Bus (A)
V_1	$D\_ * 0.50 * I_1$
V_4	$D\_ * 0.50 * I_4$

This will ensure the maximum loading at 100% load without exceeding the overall power supply's rated dc output power. It will also allow calculation of appropriate currents for other loading levels, as denoted by *X%*.

7. Measurement Procedures

Step 1. Record all the input and output specifications of the ac-to-dc power supply provided by the manufacturer in the power supply specification sheet. These may include one or more of the following specifications:

- Rated input ac voltage
- Rated input ac voltage range
- Rated input ac current
- Rated input ac current range
- Rated input frequency
- Rated input frequency range
- Rated output dc power
- Rated output dc current
- Rated output dc current range
- Rated output dc bus voltage

Step 2. Calculate the loading criteria for each output voltage bus for each loading level for the UUT.

Step 3. Complete the test setup with the source, UUT, load, and measurement instrumentation. Refer to IEEE 1515 Annex B, *General Test Practices,* for general guidelines and recommended practices for measurement and instrumentation setup for testing power supplies.

Step 4. Set the power source input voltage and frequency (if programmable) as per the test requirement.

Step 5. Load the output voltage buses (using either a rheostat or an electronic dc load bank) based on the loading criteria established for the UUT within the tolerance levels specified in this protocol.

Step 6. Measure and record true rms input power, rms input voltage, rms input current, rms input current, total harmonic distortion, output dc voltage, and output current for each voltage bus.

Step 7. Calculate the efficiency of the power supply for the loading condition using the equation:

$$ç = \frac{\sum_i P_{o,i}}{P_{in}} \times 100 \qquad \textbf{\textit{Eq. 7-1}}$$

where P_{in} is the true rms input power and $P_{o,i}$ is the output power of the i^{th} bus.

Step 8. Repeat this procedure for other loading conditions.

7.1. Test Report

In the test report, graphically display the key data (measured and calculated) from the test along with a description of the power supply that includes the manufacturer's model name and model number, specifications, and loading criteria. Appendix A gives an example test report for a server power supply and a graphical representation of power supply efficiency under different loading conditions.

A. Example Efficiency Report for an Internal Server Power Supply

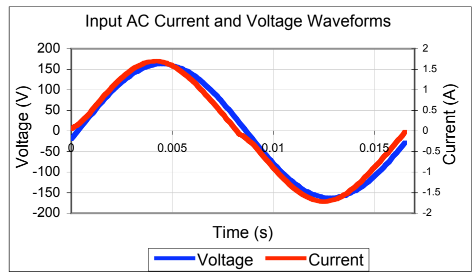
Server Power Supply Efficiency Test Report

TYPICAL EFFICIENCY (50% Load): 77%
AVERAGE EFFICIENCY : 75%

Serial Number	2
Manufacturer	Delta Electronics
Model	DPS-20PB -118 B Rev 04
Serial	BZT0237025302
Year	2002
Type	TPS1U
Test Date	6/14/2004

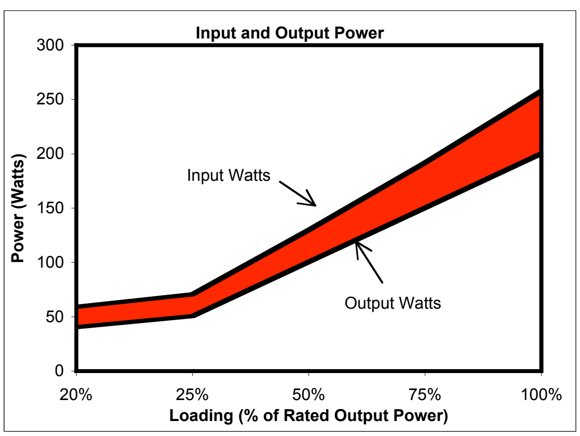
Rated Specifications	**Value**	**Units**
Input Voltage	100~127/ 200~240	Volts
Input Current	3.2/1.6	Amps
Input Frequency	50-60	Hz
Combined Max. Output Power on 5V and 3.3V	152.9	Watts
Rated Output Power	**202.9**	**Watts**

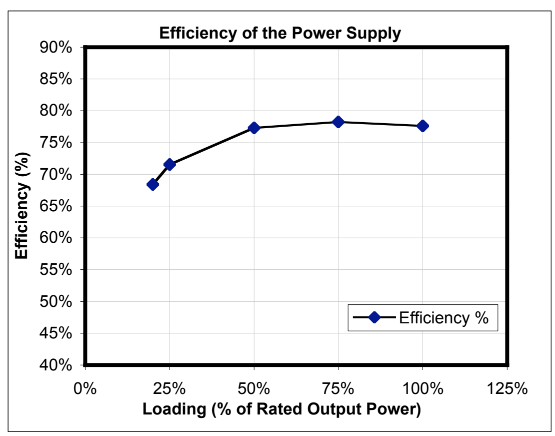
Note: All measurements were taken with input voltage at 115 V nominal and 60 Hz.



Input AC Current Waveform (I_{THD} = 5.7% at 50% Load)

I_{RMS} A	PF	I_{THD} (%)	Load (%)	Fraction of Load	Input Watts	DC Terminal Voltage (V)/ DC Load Current (A) 12.0/6.0	5.0/22.0	3.3/13.0	-12.0/0.25	5.0 SB/1.0	Output Watts	Efficiency %
0.56	0.92	7.9%	20%	**Light**	59	12.0/0.95	4.98/3.47	3.30/2.06	-	4.99/1.00	41	**68%**
1.15	0.98	5.7%	50%	**Typical**	130	11.9/2.57	4.98/9.41	3.24/5.58	-	4.97/1.00	100	**77%**
2.25	0.99	3.3%	100%	**Full**	258	12.0/5.27	4.88/19.34	3.28/11.42	-	4.97/1.00	200	**78%**





These tests were conducted as a part of California Energy Commision initiative to improve the efficiency of the server power supplies used in the Data Centers through the Public Interest Energy Research (PIER) program.
Tested by EPRI PEAC Corporation,Knoxville, TN.

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NOTE: for more sample test reports, please refer to www.efficientpowersupplies.org.

B. Typical Form Factors for Server Power Supplies

Figure B-1: 1U Server Power Supply

Figure B-2: 2U Server Power Supply

Figure B-3: Redundant Server Power Supply (Pedestal Servers)

C. Typical Output Rating for Server Power Supplies

Output ratings of a cross-section of internal server power supplies used in various product classes and their loading criteria are shown in the tables below.

Table C-1: Output Specification of a 250 W 1U Server Power Supply for an EPS 1U Form Factor

Output Voltage	Min. Current (A)	Max. Current (A)	Peak Current (A)
+3.3 V	0.5	16	-
+5 V	0.5	12	-
12 V1	0.2	16	22A
12 V2	0.5	10	
-12 V	0	0.5	-
+5 VSB	0.1	2	-

Table C-2: Output Specification of a 480 W 2U Server Power Supply for an EPS 2U Form Factor

Output Voltage	Min. Current (A)	Max. Current (A)	Peak Current (A)
+3.3 V	0.8	24	-
+5 V	0.5	20	-
12 V1	0	18	22A
12 V2	1	18	
-12 V	0	0.5	-
+5 VSB	0.1	2	-

Table C-3: Output Specification of a 550 W Pedestal Server Power Supply for an ERP12V Form Factor

Output Voltage	Min. Current (A)	Max. Current (A)	Peak Current (A)
+3.3 V	0.8	20	-
+5 V	0.5	24	-
12 V1	0	18	22A
12 V2	0.9	12	
12 V3	0	8	13A
-12 V	0	0.5	-
+5 VSB	0.1	2	